File Systems

File Systems — motivation

goal: enable storing of large data amounts
- store data/program consistently + persistently
- easily look up previously stored data/program

file types:
- *data* (numeric, character, binary)
- *program*

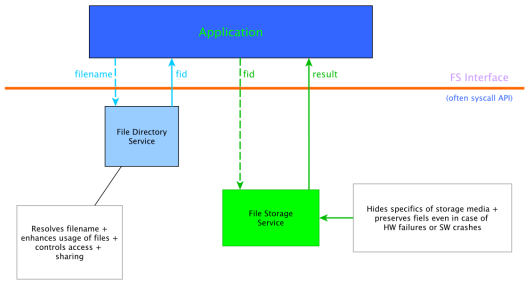
File Systems — overview

OS may support multiple file systems

namespace: all file systems typically bound into single namespace (often hierarchical, rooted tree)

Files – abstract operations

file: abstract data type/object, offering
- `create`, `write`, `read`,
- `reposition` (within file),
- `delete`, `truncate`,
- `open`(F_i) (search directory structure on disk for entry F_i, move meta data to memory),
- `close`(F_i) (move cached meta data of entry F_i in memory to directory structure on disk)



File Management — goals

provide convenient file naming scheme

provide uniform I/O support for variety of storage device types

provide standardized set of I/O interface functions

minimize/eliminate loss/corruption of data

provide I/O support + access control for multiple users

enhance system administration (e.g., backup)

provide acceptable performance

File Management — open files

several meta data is needed to manage open files

file pointer: pointer to last read/write location, per process that has file opened

access rights: per-process access mode information

file-open count: counter of number of times a file is opened (to allow removal of data from open-file table when last process closes)

disk location: cache of data access information

File Access

strictly sequential (early systems):
- read all bytes/records from beginning
- cannot jump round, could only rewind
- sufficient as long as storage was a tape

random access (current systems):
- bytes/records read in any order
- essential for database systems

Directories — goals

naming: convenient to users
- two users can have same name for different files
- same file can have several different names

grouping: logical grouping of files by properties

efficiency: fast operations

Files — sharing

issues:
- efficiently access to same file?
- how to determine access rights?
- management of concurrent accesses?

access rights:
- *none*: existence unknown to user, user cannot read directory containing file
- *knowledge*: user can only determine existence and file ownership
- *execution*: user can load + execute program, but can not copy it
- *reading*: user can read file (includes copying + execution)
- *appending*: user can only add data to file, but cannot modify/delete data in file
- *updating*: user can modify + delete + add to file (includes creating + removing all data)
- *change protection*: user can change access rights granted to other users
- *deletion*: user can delete file
- *owner*: all previous rights + rights granting

concurrent access:
- *application locking*: application can lock entire file or individual records for updating
- *exclusive vs. shared*: writer lock vs. multiple readers allowed
- *mandatory vs. advisory*: access denied depending on locks vs. process can decide what to do